FOREST PEST MANAGEMENT
Pacific Southwest Region

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**Pest Evaluation of Timber Stands in the Upper Cow Analysis Area, Summit Ranger District, Stanislaus National Forest**

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INTRODUCTION/BACKGROUND:

On July 1, 1999, we met with Tracy Stelman and visited two sites (Stands #3 and #74) within the Upper Cow Analysis Area. Small pockets of tree mortality within the area prompted the District to request a Forest Pest Management (FPM) evaluation. Our objectives were to identify the causes of mortality and determine what management options were feasible to deal with the mortality.

Most of the analysis area lies between 5800' and 7200' elevation and contains mixed conifer stands that are very heavy to white fir. Basal areas run as high as 360-400 sq. ft./acre. In 1986, the Cow Timber Sale logged many of the stands. Salvage logging has occurred repeatedly within the project area, especially along Highway 108.

OBSERVATIONS:

**Stand #3**

Stand #3 lies adjacent to Cow Creek cabins #43 and #45. The site is very open with numerous stumps and down logs, which are mostly white fir. Most of the mortality appeared to have occurred over the last 4-6 years, and there was very little current mortality. Fresh conks of *Heterobasidion annosum*, which causes annosus root disease, were found in a 26-inch diameter white fir stump while galleries of *Scolytus ventralis* (fir engraver beetle) were common on down

white fir boles (biologies of the key pests mentioned are described at the end of this report). Old white fir top-kills were evident in the stand, presumably due to fir engraver attacks. In addition, some Ribes leaves were producing spores of *Cronartium ribicola*, the cause of white pine blister rust. Branch flagging, which appeared to be due to blister rust, was observed 60 feet or higher in some sugar pine. Rust cankers were also present on seedling and sapling size sugar pine. Other scattered overstory sugar pine had old top-kills most likely due to attacks by pine engravers (*Ips* spp.). White fir dwarf mistletoe (*Arceuthobium abietinum* f. sp. *concoloris*) was present but at very light levels.

**Stand #74**

This stand is located along forest road 5N12. Vegetation is similar in composition as Stand #3 except that the trees are smaller, basal area is higher and there are very few stumps. There are numerous pockets of older tree mortality and top-kill, mostly white fir, and fuel loading is high due to standing snags and down logs. True mistletoe (*Phoradendron bolleanum* ssp. *pauci-florum*) is present in the upper crowns of several white fir but does not appear to be a factor contributing to tree mortality. Annosus root disease was found in an adjacent stand but not in Stand #74. Mortality was most likely due to a combination of overstocking, drought conditions in the late 80's and early 90's, and *Scolytus ventralis*.

DISCUSSION/CONCLUSIONS:

White fir accounts for almost all of the tree mortality, and the primary tree-killing agent in these stands is the fir engraver. Competition between trees due to dense stocking and the extended drought conditions in the late 80's and early 90's put trees under enough stress to make them more susceptible to *Scolytus ventralis*. Lesser pests include annosus root disease, white pine blister rust, white fir dwarf mistletoe and white fir true mistletoe. Although these lesser pests may not be directly causing current tree mortality, they can predispose fir to *Scolytus ventralis* attacks. Because they will remain resident on the sites, they should be considered in future management decisions.

From a tree health perspective, the traditional view of these pests is that they are harmful. However, from a wildlife management standpoint, the effects of pests in a stand may be viewed as positive. Snags, down woody material, and dead tops created by insects and pathogens may be desirable. Bark beetles and annosus root disease create openings in the stand that benefit wildlife and increase structural and species diversity. Dwarf and leafy mistletoe plants and fruit are food sources for insects, birds and mammals. Finally, dwarf mistletoe witches' brooms may provide cover and nesting sites for many wildlife species.

## No Stand Management

Without any management, insect and disease caused injury or mortality will continue. Specifically, future top-kill and mortality of white fir caused by the fir engraver can be expected. Mortality levels may fluctuate from year to year, but over time, will be higher than expected in managed stands. Periods of drought will contribute to accelerated or elevated mortality and top-kill.

Annosus root disease centers will enlarge and most fir regeneration within centers will likely die. New disease centers may be initiated through wounds or freshly cut stump tops. White fir would be the only species affected.

Dwarf and true mistletoes, while currently at low levels in white fir, will spread to other white fir and intensify in trees already infected. True mistletoe infections in the upper crown will ultimately cause dead tops, while the long-term effect of dwarf mistletoe will be primarily growth reduction and predisposition to fir engraver attacks.

White pine blister rust will kill all susceptible sugar pine regeneration. The only sugar pine that will survive in the units are those already too large to sustain lethal cankers and those few trees that are genetically resistant to the rust. Sugar pine will continue to be at risk to mountain pine beetle and *Ips* attacks, particularly in overstocked aggregations and during periods of drought.

## Management Options

Preventing future mortality and increasing stand health can be accomplished by regulating stand density and composition and by focusing on controlling root disease spread.

1. **Regulate Stocking**: Thin stands to stocking levels that the site can sustain. The intent is to create and maintain growing conditions that allow trees to be healthy and vigorous enough to prevent future mortality from bark and engraver beetles. In general, thinning should attempt to reduce stocking levels to about 55% of normal (fully stocked) to reduce future bark beetle related mortality. Thinning also provides an opportunity to selectively remove unhealthy, defective or diseased trees.

2. **Regulate Species Composition:** Some bark/engraver beetles and many diseases attack only one or two tree species in any given stand. Increasing tree species diversity will reduce the potential for a single pest to cause significant damage over large areas. Since most of the mortality in Upper Cow is white fir, increasing the proportion of pines (assuming they are suitable for the site) would be beneficial. If any sugar pine is planted, it should be resistant to white pine blister rust.

3. **Root Disease Management**: Justifying control of annosus root disease is not always straightforward in true fir stands because it is difficult to accurately assess its exact distribution or impact. Trees may be infected but not show any obvious outward symptoms of disease. It is common to underestimate the amount of root disease in stands where true fir is affected. Several

control options are feasible. Additional information on the biology and management of this root disease may be found in Forest Service Handbook 3409.11, R5 Supplement No. 3409.11-94-1.

a. Sporax treatment. Treating freshly cut stumps with Sporax will prevent new disease centers from starting, but will have little effect on established centers. Because we verified the presence of this root disease at several locations within the Upper Cow area, the use of Sporax is warranted and should be considered as a control option. Stumps less than 12 inches in diameter rarely initiate new infection centers and, therefore, do not need to be treated.

b. Favor resistant species. The form of *H. annosum* ("S" type) present will only infect true fir and possibly giant sequoia. Pines, incense-cedar, and hardwoods are not hosts for this type. Favoring or planting these resistant species is appropriate especially within or near identified or suspected root disease sites.

c. Isolate known disease centers. Removing all white fir within a 50-75 foot zone around the perimeter of disease centers may isolate the fungus and stop its spread into the stand. All cut stumps would have to be treated with Sporax. This procedure is based on our understanding of disease spread and biology, but has not always been effective under California conditions. The treatment would certainly increase the size of openings caused by root disease, which could then be revegetated with pines, incense-cedar, or hardwoods.

4. **Minimize damage to residual trees:** The following guidelines were developed by the Pacific Northwest Research Station and the Region 5 Silvicultural Development Unit and apply to managing second growth true fir stands. These guidelines are intended to minimize logging injury and thereby reduce future losses from decay, including annosus root disease.

a. Restrict time of logging. Do not allow entry during the spring and early summer when tree bark is loose and the likelihood of mechanical damage is greatest.

b. Restrict the size and type of logging equipment. Match the logging system to the topography and use the smallest size of equipment to get the job done.

c. Mark leave trees rather than cut trees.

d. Lay out skid roads in advance of logging. Skid trails should not be cleared wider than the skidding vehicle. Use straight-line skid trails.

e. Leave buffer (bump) trees. When possible, leave cull logs and bump trees along the edges of skid trails. Remove bump trees during the last turn.

f. Limit log length. Relate log length to the spacing of the residual stand.

g. Log skid trails first. Cut the stumps in skid trails as low as possible, preferably 3-4 inches high.

h. Use directional falling. Fall trees toward or away from the skid trails to reduce skidder maneuvering.

i. Limb, top, and buck trees prior to skidding.

j. Do not thin stands of thin-barked trees too heavily. Sunscald can cause considerable damage.

k. Work closely with contractor. Instruct operators in methods of reducing damage. Inform contractor that damage will not be tolerated. Communicate clearly the desired results to the contractor - close supervision may be necessary, especially with inexperienced operators.

## Biologies of Pest Organisms

### Annosus Root Disease In True Fir

*Heterobasidion annosum* (formerly *Fomes annosus*) is a fungus that attacks a wide variety of woody plants. All western conifer species are susceptible. Madrone and a few brush species (*Arctostaphylos* spp. and *Artemisia tridentata*) are occasional hosts. Other hardwood species are apparently not infected. The disease has been reported on all the National Forests in California, with incidence particularly high on true fir in northern California campgrounds. Incidence is somewhat higher in older, larger fir stands and in stands with high basal areas (over about 330 square feet/acre).

During periods favorable to the fungus, fruiting bodies (conks) form in decayed stumps, under the bark of dead trees, or under the duff at the root collar (rare in California). New infection centers begin by aerial spread of spores produced by the conks and subsequent colonization of freshly cut stump surfaces or wounds on living trees. The fungus then spreads through root contacts into the root systems of adjacent live true fir. Local spread of the fungus from a stump typically results in the formation of a disease center, with dead trees in the center and fading trees on the margin. These centers usually continue to enlarge until they reach natural barriers such as stand openings or non-susceptible plants.

In pines, *H. annosum* grows through root cambial tissue to the root crown where it girdles and kills the trees. In less resinous species such as true firs, the fungus sometimes kills trees, but more frequently it is confined to the heartwood and inner sapwood of the larger roots where it causes a chronic butt and root decay and growth loss. Thus, while infection in true fir usually does not kill the host, it does affect its growth and thriftiness. Losses in true fir from *H. annosum* are mainly the result of windthrow because of root decay, and reduced root systems that predispose trees to attack and eventual death by the fir engraver beetle. Field observations suggest that vigorous young firs are usually able to regenerate root tissues faster than they are lost to the root disease. But when true firs slow in growth because of stand and/or site conditions, root development decreases to where there is a net loss in roots and the trees slowly decline due to the gradual loss of their root systems. This decline may take 10 to 20 years before tree death occurs.

There are two pathogenic strains of the fungus that differ in their ability to infect various conifers in California. The "P" or pine type infects and kills all pines (although susceptibility of pine species vary), in addition to incense-cedar and western juniper. The "S" or fir type infects true fir, Douglas fir and giant sequoia. Knowing which type is active in a stand is important, and will allow favoring alternate conifer species because the fungus strains do not cross infect between the two groups listed above.

## Fir Engraver

The fir engraver (*Scolytus ventralis*) attacks both white and red fir in California. Trees ranging in size from large saplings to overmature sawtimber are susceptible. Attacks can cause patch killing of cambium along the bole, top-kill, or tree death. Top-kill or death occur most often in firs that have been weakened by root disease, dwarf mistletoe, overstocking, soil compaction, sunscald, logging injury, or drought. The fir engraver also breeds in slash and windthrown trees.

The fir engraver usually completes its life cycle in one year, sometimes two. Adults fly and bore into trees or green fir slash from June to September; larvae, pupae, and adults over-winter under the bark. Pitch tubes are not formed as they are with pine bark beetles; the usual evidence of attack is boring dust in bark crevices along the trunk and pitch streamers on the mid and upper bole. Trees colonized early in the summer may begin to fade by early fall, but those colonized later in the year usually do not fade until the following spring or summer, often after the beetles have emerged.

## White Pine Blister Rust

Blister rust (*Cronartium ribicola*) is caused by an obligate parasite that attacks sugar and western white pines and several species of *Ribes*. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on *Ribes*. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to *Ribes* where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves re-infect other *Ribes* throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on *Ribes* leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to *Ribes* to continue the cycle. Although blister rust may spread hundreds of miles from pines to *Ribes*, its spread from *Ribes* back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers (these are called **lethal** cankers). Bole cankers result in girdling and death of the tree above the canker. Cankers whose closest margins are more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result (these are called **non-lethal** cankers).

Environmental conditions are critical for successful infection and limit the disease in most years. Moisture and low temperatures favor infection of both hosts, and must coincide with spore dispersal for infection to occur. In California, these conditions occur only infrequently, usually in cool moist sites such as stream bottoms or around meadows. In so called "wave years" when favorable conditions occur, high levels of infection can result. Wave years in California have occurred at approximately ten-year intervals in the past. As one moves from sites most favorable for rust to less favorable sites, the frequency of wave years decreases.

## White Fir Dwarf Mistletoe

Dwarf mistletoe on white fir (*Arceuthobium abietinum* f. sp. *concoloris*) is a parasitic, flowering plant that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seed is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal

distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occassionaly vectored by birds and animals.

Vertical spread of mistletoe within white fir crowns is normally limited to less than one foot per year because of foliage density. In contrast, because of the thin foliage of gray pine, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings (cankers).

**White Fir True Mistletoe**

White fir mistletoe, Phoradendron bolleanum ssp. pauciflorum, is a true mistletoe having small, green leaves and round, white berries. It can only survive in living white fir tissues, principally as a water parasite utilizing water and minerals from the host. In California, it is limited geographically to the Sierra Nevada south of Interstate 80, and to the mountains of southern California.

This pest is spread mainly by birds, including robins, bluebirds, thrushes, phainopeplas, and cedar waxwings. Birds feed on the berries, digest their pulp, and excrete the living seed, often depositing them onto susceptible trees. A viscous coating and hair-like threads on the outer surface of the seeds attach them firmly to twigs and branches, where they germinate and infect host tissues.

Young or small trees are seldom infected by white fir mistletoe. In nearly all cases, initial infection occurs on the branches of larger or older trees because birds prefer to perch in their tops. Severe buildup of mistletoe often occurs in an already-infected tree because birds are attracted to and may spend prolonged periods feeding on the mistletoe berries.

Heavily infected trees are weakened, reduced in growth rate, and sometimes killed. Weakened trees are predisposed to attacks by insects and often die during drought or other periods of stress. Severe infection of white fir can result in top-kill in combination with the fir engraver (*Scolytus ventralis*). Branches and tree tops heavily-laden with true mistletoe often break during wind storms, increasing the hazard to people and property in campgrounds and other developed sites.

White fir mistletoe is recognized by the clumps of mistletoe foliage in the tree. These mistletoe plants are usually in the tops of larger, older trees. With severe infections, virtually all of the tree's foliage may be replaced by mistletoe plants. Dead spiked tops are common in white fir stands heavily infected by this parasite.